

Amendments to the Claims:

Please cancel claims 1612, 1651, and 5401 without prejudice.

The following lists all claims and their status:

1-1607 (cancelled)

1608. (currently amended): A method of treating a hydrocarbon containing formation in situ, comprising:

providing heat from one or more heaters positioned in heater wells to at least a portion of the formation;

allowing the heat to transfer from the one or more ~~of the~~ heaters to a part of the formation;

wherein the part of the formation has been selected for heating using an atomic hydrogen weight percentage of at least a portion of hydrocarbons in the part of the formation, and wherein at least the portion of the hydrocarbons in the part of the formation comprises an atomic hydrogen weight percentage, when measured on a dry, ash-free basis, of greater than about 4.0 %; and

producing a mixture from the formation.

1609. (currently amended): The method of claim 1608, wherein the one or more ~~of the~~ heaters comprise at least two heaters, and wherein controlled superposition of heat from at least the two heaters pyrolyzes at least some hydrocarbons ~~within~~ in the part of the formation.

1610. (currently amended): The method of claim 1608, further comprising maintaining a temperature ~~within~~ in the part of the formation ~~within~~ in a pyrolysis temperature range of about 270 °C to about 400 °C.

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1611. (previously amended): The method of claim 1608, wherein at least one of the one or more heaters comprises an electrical heater.

1612. (cancelled)

1613. (previously amended): The method of claim 1608, wherein at least one of the one or more heaters comprises a flameless distributed combustor.

1614. (previously amended): The method of claim 1608, wherein at least one of the one or more heaters comprises a natural distributed combustor.

1615. (currently amended): The method of claim 1608, further comprising controlling a pressure and a temperature ~~within~~in at least a majority of the part of the formation, wherein the pressure is controlled as a function of temperature, or the temperature is controlled as a function of pressure.

1616. (currently amended): The method of claim 1608, further comprising pyrolyzing hydrocarbons ~~within~~in the part of the formation, and controlling the heat such that an average heating rate of the part of the formation is less than about 1 °C per day ~~during~~in a pyrolysis temperature range of about 270 °C to about 400 °C.

1617. (currently amended): The method of claim 1608, wherein providing heat from the one or more ~~of the~~ heaters to at least the portion of the formation comprises:

heating a selected volume (V) of the hydrocarbon containing formation from one or more of the heaters, wherein the formation has an average heat capacity (C_v), and wherein the heating pyrolyzes at least some hydrocarbons ~~within~~in the selected volume of the formation; and

wherein heating energy/day (P_{wr}) provided to the selected volume is equal to or less than $h \cdot V \cdot C_v \cdot \rho_B$, wherein ρ_B is formation bulk density, and wherein an average heating rate (h) of the selected volume is about 10 °C/day.

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1618. (original): The method of claim 1608, wherein allowing the heat to transfer comprises transferring heat substantially by conduction.

1619. (currently amended): The method of claim 1608, wherein allowing the heat to transfer to the part of the formation heats ~~providing heat from one or more of the heaters comprises heating the part of the formation such that to increase~~ a thermal conductivity of at least a portion of the part of the formation ~~is to~~ greater than about 0.5 W/(m °C).

1620. (original): The method of claim 1608, wherein the produced mixture comprises condensable hydrocarbons having an API gravity of at least about 25°.

1621. (original): The method of claim 1608, wherein the produced mixture comprises condensable hydrocarbons, and wherein about 0.1 % by weight to about 15 % by weight of the condensable hydrocarbons are olefins.

1622. (original): The method of claim 1608, wherein the produced mixture comprises non-condensable hydrocarbons, and wherein a molar ratio of ethene to ethane in the non-condensable hydrocarbons ranges from about 0.001 to about 0.15.

1623. (original): The method of claim 1608, wherein the produced mixture comprises condensable hydrocarbons, and wherein less than about 1 % by weight, when calculated on an atomic basis, of the condensable hydrocarbons is nitrogen.

1624. (original): The method of claim 1608, wherein the produced mixture comprises condensable hydrocarbons, and wherein less than about 1 % by weight, when calculated on an atomic basis, of the condensable hydrocarbons is oxygen.

1625. (original): The method of claim 1608, wherein the produced mixture comprises condensable hydrocarbons, and wherein less than about 1 % by weight, when calculated on an atomic basis, of the condensable hydrocarbons is sulfur.

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1626. (original): The method of claim 1608, wherein the produced mixture comprises condensable hydrocarbons, wherein about 5 % by weight to about 30 % by weight of the condensable hydrocarbons comprise oxygen containing compounds, and wherein the oxygen containing compounds comprise phenols.

1627. (original): The method of claim 1608, wherein the produced mixture comprises condensable hydrocarbons, and wherein greater than about 20 % by weight of the condensable hydrocarbons are aromatic compounds.

1628. (original): The method of claim 1608, wherein the produced mixture comprises condensable hydrocarbons, and wherein less than about 5 % by weight of the condensable hydrocarbons comprises multi-ring aromatics with more than two rings.

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1629. (original): The method of claim 1608, wherein the produced mixture comprises condensable hydrocarbons, and wherein less than about 0.3 % by weight of the condensable hydrocarbons are asphaltenes.

1630. (original): The method of claim 1608, wherein the produced mixture comprises condensable hydrocarbons, and wherein about 5 % by weight to about 30 % by weight of the condensable hydrocarbons are cycloalkanes.

1631. (currently amended) The method of claim 1608, wherein the produced mixture comprises a non-condensable component that does not condense at 25° C and one atmosphere absolute pressure, wherein the non-condensable component comprises molecular hydrogen, wherein the molecular hydrogen is greater than about 10 % by volume of the non-condensable component, and wherein the molecular hydrogen is less than about 80 % by volume of the non-condensable component.

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1632. (original): The method of claim 1608, wherein the produced mixture comprises ammonia, and wherein greater than about 0.05 % by weight of the produced mixture is ammonia.

1633. (original): The method of claim 1608, wherein the produced mixture comprises ammonia, and wherein the ammonia is used to produce fertilizer.

1634. (currently amended): The method of claim 1608, further comprising controlling a pressure ~~within~~in at least a majority of the part of the formation, wherein the controlled pressure is at least about 2.0 ~~bar~~bars absolute.

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1635. (currently amended): The method of claim 1608, further comprising controlling formation conditions to produce the mixture, wherein a partial pressure of H₂ ~~within~~in the mixture is greater than about 0.5 bar.

1636. (currently amended): The method of claim 1635, wherein the partial pressure of H₂ ~~within~~in the mixture is measured when the mixture is at a production well.

1637. (currently amended): The method of claim 1608, further comprising altering a pressure ~~within~~in the formation to inhibit production of hydrocarbons from the formation having carbon numbers greater than about 25.

1638. (original): The method of claim 1608, further comprising controlling formation conditions by recirculating a portion of hydrogen from the mixture into the formation.

1639. (currently amended): The method of claim 1608, further comprising:
providing hydrogen (H₂) to the heated part of the formation to hydrogenate hydrocarbons ~~within~~in the part of the formation; and
heating a portion of the part of the formation with heat from hydrogenation.

1640. (original): The method of claim 1608, further comprising:

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producing hydrogen and condensable hydrocarbons from the formation; and
hydrogenating a portion of the produced condensable hydrocarbons with at least a portion
of the produced hydrogen.

1641. (currently amended): The method of claim 1608, wherein allowing the heat to transfer
~~comprises increasing~~ increases a permeability of a majority of the part of the formation to greater
than about ~~100-250~~ millidarcy.

1642. (currently amended): The method of claim 1608, wherein allowing the heat to transfer
~~comprises increasing~~ increases a permeability of a majority of the part of the formation such that
the permeability of the majority of the part is substantially uniform.

1643. (original): The method of claim 1608, further comprising controlling the heat to yield
greater than about 60 % by weight of condensable hydrocarbons, as measured by the Fischer
Assay.

1644. (previously amended): The method of claim 1608, wherein producing the mixture
comprises producing the mixture in a production well, and wherein at least about 7 heaters are
disposed in the formation for each production well.

1645. (currently amended): The method of claim 1608, further comprising providing heat from
~~three or more~~ heaters to at least a portion of the formation, wherein ~~three or more~~ of the heaters
are located in the formation in a unit of heaters, and wherein the unit of heaters comprises a
triangular pattern.

1646. (currently amended): The method of claim 1608, further comprising providing heat from
~~three or more~~ heaters to at least a portion of the formation, wherein ~~three or more~~ of the heaters
are located in the formation in a unit of heaters, wherein the unit of heaters comprises a triangular
pattern, and wherein a plurality of the units are repeated over an area of the formation to form a
repetitive pattern of units.

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1647. (currently amended): A method of treating a hydrocarbon containing formation in situ, comprising:

providing heat from one or more heaters positioned in heater wells to at least a portion of the formation;

allowing the heat to transfer from the one or more ~~of the~~ heaters to a part of the formation;

wherein at least some hydrocarbons ~~within in~~ the part of the formation have an initial atomic hydrogen weight percentage of greater than about 4.0 %; and

producing a mixture from the formation.

1648. (currently amended): The method of claim 1647, wherein the one or more ~~of the~~ heaters comprise at least two heaters, and wherein controlled superposition of heat from at least the two heaters pyrolyzes at least some hydrocarbons ~~within in~~ the part of the formation ~~of the formation~~.

1649. (currently amended): The method of claim 1647, further comprising maintaining a temperature ~~within in~~ the part of the formation ~~within in~~ a pyrolysis temperature range of about 270 °C to about 400 °C.

1650. (previously amended): The method of claim 1647, wherein at least one of the one or more heaters comprises an electrical heater.

1651. (cancelled)

1652. (previously amended): The method of claim 1647, wherein at least one of the one or more heaters comprises a flameless distributed combustor.

1653. (previously amended): The method of claim 1647, wherein at least one of the one or more heaters comprises a natural distributed combustor.

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1654. (currently amended): The method of claim 1647, further comprising controlling a pressure and a temperature ~~within in~~ at least a majority of the part of the formation ~~of the formation~~, wherein the pressure is controlled as a function of temperature, or the temperature is controlled as a function of pressure.

1655. (currently amended): The method of claim 1647, further comprising pyrolyzing hydrocarbons ~~within in~~ the part of the formation, and controlling the heat such that an average heating rate of the part of the formation is less than about 1 °C per day ~~during in a~~ pyrolysis temperature range of about 270 °C to about 400 °C.

1656. (currently amended): The method of claim 1647, wherein providing heat from the one or more ~~of the~~ heaters to at least the portion of the formation comprises:

heating a selected volume (V) of the hydrocarbon containing formation from one or more of the heaters, wherein the formation has an average heat capacity (C_v), and wherein the heating pyrolyzes at least some hydrocarbons ~~within in~~ the selected volume of the formation; and

wherein heating energy/day (P_{wr}) provided to the selected volume is equal to or less than $h \cdot V \cdot C_v \cdot \rho_B$, wherein ρ_B is formation bulk density, and wherein an average heating rate (h) of the selected volume is about 10 °C/day.

1657. (original): The method of claim 1647, wherein allowing the heat to transfer comprises transferring heat substantially by conduction.

1658. (currently amended): The method of claim 1647, wherein allowing the heat to transfer to the part of the formation heats ~~providing heat from one or more of the heaters comprises heating~~ the part of the formation ~~such that~~ to increase a thermal conductivity of at least a portion of the part of the formation ~~is to~~ greater than about 0.5 W/(m °C).

1659. (original): The method of claim 1647, wherein the produced mixture comprises condensable hydrocarbons having an API gravity of at least about 25°.

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1660. (original): The method of claim 1647, wherein the produced mixture comprises condensable hydrocarbons, and wherein about 0.1 % by weight to about 15 % by weight of the condensable hydrocarbons are olefins.

1661. (original): The method of claim 1647, wherein the produced mixture comprises non-condensable hydrocarbons, and wherein a molar ratio of ethene to ethane in the non-condensable hydrocarbons ranges from about 0.001 to about 0.15.

1662. (original): The method of claim 1647, wherein the produced mixture comprises condensable hydrocarbons, and wherein less than about 1 % by weight, when calculated on an atomic basis, of the condensable hydrocarbons is nitrogen.

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1663. (original): The method of claim 1647, wherein the produced mixture comprises condensable hydrocarbons, and wherein less than about 1 % by weight, when calculated on an atomic basis, of the condensable hydrocarbons is oxygen.

1664. (original): The method of claim 1647, wherein the produced mixture comprises condensable hydrocarbons, and wherein less than about 1 % by weight, when calculated on an atomic basis, of the condensable hydrocarbons is sulfur.

1665. (original): The method of claim 1647, wherein the produced mixture comprises condensable hydrocarbons, wherein about 5 % by weight to about 30 % by weight of the condensable hydrocarbons comprise oxygen containing compounds, and wherein the oxygen containing compounds comprise phenols.

1666. (original): The method of claim 1647, wherein the produced mixture comprises condensable hydrocarbons, and wherein greater than about 20 % by weight of the condensable hydrocarbons are aromatic compounds.

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1667. (original): The method of claim 1647, wherein the produced mixture comprises condensable hydrocarbons, and wherein less than about 5 % by weight of the condensable hydrocarbons comprises multi-ring aromatics with more than two rings.

1668. (original): The method of claim 1647, wherein the produced mixture comprises condensable hydrocarbons, and wherein less than about 0.3 % by weight of the condensable hydrocarbons are asphaltenes.

1669. (currently amended): The method of claim 1647, ~~and wherein~~ the produced mixture comprises condensable hydrocarbons, and wherein about 5 % by weight to about 30 % by weight of the condensable hydrocarbons are cycloalkanes.

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1670. (currently amended): The method of claim 1647, wherein the produced mixture comprises a non-condensable component that does not condense at 25° C and one atmosphere absolute pressure, wherein the non-condensable component comprises molecular hydrogen, wherein the molecular hydrogen is greater than about 10 % by volume of the non-condensable component, and wherein the molecular hydrogen is less than about 80 % by volume of the non-condensable component.

1671. (original): The method of claim 1647, wherein the produced mixture comprises ammonia, and wherein greater than about 0.05 % by weight of the produced mixture is ammonia.

1672. (original): The method of claim 1647, wherein the produced mixture comprises ammonia, and wherein the ammonia is used to produce fertilizer.

1673. (currently amended): The method of claim 1647, further comprising controlling a pressure ~~within in~~ at least a majority of the part of the formation of the formation, wherein the controlled pressure is at least about 2.0 ~~bar~~ bars absolute.

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1674. (currently amended): The method of claim 1647, further comprising controlling formation conditions to produce the mixture, wherein a partial pressure of H₂ ~~within~~in the mixture is greater than about 0.5 bar.

1675. (currently amended): The method of claim 1674, wherein the partial pressure of H₂ ~~within~~in the mixture is measured when the mixture is at a production well.

1676. (currently amended): The method of claim 1647, further comprising altering a pressure ~~within~~in the formation to inhibit production of hydrocarbons from the formation having carbon numbers greater than about 25.

1677. (original): The method of claim 1647, further comprising controlling formation conditions by recirculating a portion of hydrogen from the mixture into the formation.

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1678. (currently amended): The method of claim 1647, further comprising:
providing hydrogen (H₂) to the heated part of the formation to hydrogenate hydrocarbons ~~within~~in the part of the formation; and
heating a portion of the part of the formation with heat from hydrogenation.

1679. (original): The method of claim 1647, further comprising:
producing hydrogen and condensable hydrocarbons from the formation; and
hydrogenating a portion of the produced condensable hydrocarbons with at least a portion of the produced hydrogen.

1680. (currently amended): The method of claim 1647, wherein allowing the heat to transfer ~~comprises increasing~~increases a permeability of a majority of the part of the formation to greater than about ~~100~~250 millidarcy.

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1681. (currently amended): The method of claim 1647, wherein allowing the heat to transfer ~~comprises increasing~~ increases a permeability of a majority of the part of the formation such that the permeability of the majority of the part of the formation is substantially uniform.

1682. (original): The method of claim 1647, further comprising controlling the heat to yield greater than about 60 % by weight of condensable hydrocarbons, as measured by the Fischer Assay.

1683. (previously amended): The method of claim 1647, wherein producing the mixture comprises producing the mixture in a production well, and wherein at least about 7 heaters are disposed in the formation for each production well.

1684. (currently amended): The method of claim 1647, further comprising providing heat from ~~three or more~~ heaters to at least a portion of the formation, wherein ~~three or more~~ of the heaters are located in the formation in a unit of heaters, and wherein the unit of heaters comprises a triangular pattern.

1685. (currently amended): The method of claim 1647, further comprising providing heat from ~~three or more~~ heaters to at least a portion of the formation, wherein ~~three or more~~ of the heaters are located in the formation in a unit of heaters, wherein the unit of heaters comprises a triangular pattern, and wherein a plurality of the units are repeated over an area of the formation to form a repetitive pattern of units.

1686-5395 (cancelled)

5396. (previously amended): The method of claim 1644, wherein at least about 20 heaters are disposed in the formation for each production well.

5397. (previously amended): The method of claim 1683, wherein at least about 20 heaters are disposed in the formation for each production well.

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5398. (previously added): The method of claim 1608, wherein the part of the formation comprises a pyrolysis zone.

5399. (previously added): The method of claim 1647, wherein the part of the formation comprises a pyrolysis zone.

5400. (currently amended): A method of treating a hydrocarbon containing formation in situ, comprising:

providing heat from one or more heaters positioned in heater wells to at least a portion of the formation;

allowing the heat to transfer from the one or more ~~of the~~ heaters to a selected section of the formation;

wherein at least some hydrocarbons ~~within~~ in the selected section have an initial atomic hydrogen weight percentage of greater than about 4.0 %; and

producing a mixture from the formation.

5401. (cancelled)

5402. (currently amended): The method of claim 5400, wherein the one or more heaters comprise at least two heaters, and wherein controlled superposition of heat from at least the two heaters pyrolyzes at least some hydrocarbons ~~within~~ in the selected section.

5403. (currently amended): The method of claim 5400, further comprising maintaining a temperature ~~within~~ in the selected section ~~within~~ in a pyrolysis temperature range of about 270 °C to about 400 °C.

5404. (currently amended): The method of claim 5400, wherein at least one of the one or more ~~of~~ heaters comprises a natural distributed combustor.

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5405. (currently amended): The method of claim 5400, further comprising controlling a pressure and a temperature ~~within-in~~ in at least a majority of the selected section of the formation, wherein the pressure is controlled as a function of temperature, or the temperature is controlled as a function of pressure.

5406. (currently amended): The method of claim 5400, further comprising pyrolyzing hydrocarbons ~~within-in~~ in the selected section and controlling the heat such that an average heating rate of the selected section is less than about 1 °C per day ~~within-in~~ in a pyrolysis temperature range of about 270 °C to about 400 °C.

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5407. (currently amended): The method of claim 5400, wherein providing heat from the one or more heaters to at least the portion of the formation comprises:

heating a selected volume (V) of the hydrocarbon containing formation from one or more of the heaters, wherein the formation has an average heat capacity (C_v), and wherein the heating pyrolyzes at least some hydrocarbons ~~within-in~~ in the selected volume of the formation; and

wherein heating energy/day (P_{wr}) provided to the selected volume is equal to or less than $h \cdot V \cdot C_v \cdot \rho_B$, wherein ρ_B is formation bulk density, and wherein an average heating rate (h) of the selected volume is about 10 °C/day.

5408. (currently amended): The method of claim 5400, further comprising controlling a pressure ~~within-in~~ in at least a majority of the selected section, wherein the controlled pressure is at least about 2.0 ~~bar-bars~~ absolute.

5409. (currently amended): The method of claim 5400, further comprising controlling formation conditions to produce the mixture, wherein a partial pressure of H_2 ~~within-in~~ in the mixture is greater than about 0.5 bar.

5410. (currently amended): The method of claim 5400, further comprising altering a pressure ~~within-in~~ in the formation to inhibit production of hydrocarbons from the formation having carbon numbers greater than about 25.

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5411. (previously added): The method of claim 5400, wherein producing the mixture comprises producing the mixture in a production well, and wherein at least about 7 heaters are disposed in the formation for each production well.

5412. (currently amended): The method of claim 5400, wherein at least about 20 ~~heat sources~~ heaters are disposed in the formation for each production well.